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# MORE MILK THROUGH BETTER BREEDING

*by George Hyatt, Jr., W. J. Tyler, and H. O. Henderson*

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION

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PART OF THE Reymann Memorial Herd waiting for feed time.

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**Agricultural Experiment Station, C. R. Orton, Director**

**College of Agriculture, Forestry, and Home Economics**

**West Virginia University, Morgantown**

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FRONT COVER: Dairy barn on the West Virginia Agricultural Experiment Station Dairy Farm, near Morgantown, home of the Reymann Memorial Ayrshire Herd. BACK COVER: Pasture scene on the same farm.

# More Milk Through Better Breeding as Shown by Research at West Virginia University

by
*G. Hyatt, Jr., W. J. Tyler, and H. O. Henderson*

## INTRODUCTION

IT IS THE PURPOSE of this publication to present a 30-year summary of the experimental work accomplished with the Reymann Memorial herd of Ayrshire cattle. This project was supplemented with research on thousands of records furnished by the Ayrshire Breeders' Association through a cooperative project with the West Virginia Agricultural Experiment Station. Much of the material presented here has appeared in the form of technical articles in the various scientific journals and in popular form in the five issues from November 10, 1947, to January 10, 1948, inclusive, of the nationally known dairy magazine, HOARD'S DAIRYMAN. Many of the findings reported here have thrown new light on the problems of dairy-cattle breeding. The dairy world, and farmers in particular, are still benefiting from the foresight, generosity, and vision of the Reymann family in bestowing the trust of the Reymann herd on the West Virginia Station.

The Lawrence A. Reymann experimental farms, situated near Wardensville, Hardy County, were presented to the State of West Virginia in 1917 by the Reymann family of Wheeling as a memorial to Lawrence A. Reymann, who died May 11, 1911, at 32 years of age. While still in his twenties, Lawrence Reymann developed a deep interest in breeding outstanding Ayrshire cattle. He established a good dairy farm on a hill overlooking the city of Wheeling on the broad Ohio River. Later, in order to avoid Bang's disease, he established a herd on a farm at Wardensville, far from other dairy herds.

As Reymann built his herd, he cooperated with the Experiment Station at West Virginia University. It was only fitting then that after his death the outstanding herd and farms were given to the University to "promote, develop, and advance the science of agriculture in its most comprehensive scope." The Ayrshire herd was to be maintained "forever" and was to be developed and improved so that very high levels of production and type would be attained.

## EXPERIMENTAL OUTLINE

Although the herd and farms were turned over to the University for purposes of research in 1917, it was 1922 before a long-range breeding program was put into effect. The original plan of the experiment was to compare out-crossing with linebreeding, through the use of proved sires, as a means of improving both type and production in dairy cattle. This plan did not materialize, however, because it was impossible to locate suitably proved linebred sires. As a result, the continued use of

good, proved sires, usually unrelated, was substituted, making it possible now to report the results, on type and production, of following such a system of breeding over a quarter of a century.

The herd was maintained on the Reymann Farms at Wardensville until 1937, when the barns burned. All the older animals (milking cows and proved bulls) were moved to the University farm at Morgantown. The heifers of breeding age were maintained at Wardensville. The distance was too great to transport the proved bulls back and forth between the two stations, and artificial breeding techniques were not available then, making it impossible for the heifers at Wardensville to be bred to proved bulls. In 1941 the young stock also was moved to Morgantown so that closer supervision of the project could be maintained. However, the practice of breeding the heifers to young unproved sires was continued.

In the early years of the project the herd was milked three times daily, but in 1943 all cows were put on twice-a-day milking for 305-day lactations. In the original outline of the project written in 1922, normal females were to be kept in the herd until each had produced a heifer calf and had completed at least one lactation record. Because of the physical impossibility of maintaining such a large herd, the project was revised in 1934, requiring only that all normal females be kept until they had completed one 305-day lactation.

In 1946 the herd was divided into two groups: one consisted of daughters of proved sires, while the other was made up of daughters of sires which were not proved at the time of their use in the herd. The daughters of proved sires are being bred to the best proved sires that can be obtained, while the daughters of young unproved sires will be bred only to carefully selected young bulls chosen from other herds. All other management conditions will remain the same. Through the division of the herd it is believed that the use of unproved sires will shed considerable light on the important problem of proper selection of young bulls, which is one of the most difficult tasks confronting the dairymen and artificial breeding associations. This project should make some very notable contribution in this field, but it will require at least another 10 years before any definite results will be available.

Throughout the years of this experiment all milking cows have been fed an approximate 12 percent-digestible-crude-protein, home-mixed grain ration. This ration in general was as follows: 300 lb. wheat bran, 200 lb. ground shelled corn; 150 lb. ground wheat, 500 lb. ground oats, 100 lb. soybean meal, 12 lb. steamed bone meal, and 17 lb. salt. No cow has been given more than 14 lb. of grain per day, while first-calf heifers have been fed a maximum of 10 lb. per day. In addition to grain, the animals have been fed good-quality hay, silage when available, and pasture in season. The practice has been to breed all heifers to freshen in the months of September, October, and November; this has helped to standardize the feeding and management conditions.

All records quoted in this publication are 305-day, twice-a-day milking, mature-equivalent records.

## IMPROVEMENT IN PRODUCTION

In order to evaluate the improvement of the herd for milk and butterfat production, the first records of all cattle born each year since 1922 have been averaged. Presented in Table 1 are the average of the milk and butterfat records of daughters of proved sires born between 1922 and 1945. Since yearly variations are somewhat large for data of this kind, the average production by 3-yr. intervals is recorded in Table 1 and is pictured in Figure 1. It appears that the daughters of the first proved sires used were inferior to the foundation cows, but since 1933 the average production of the herd has increased by about 3,000 lb.

**Table 1—Average Production (2 x 305-day M.E. basis) of Daughters of Proved Sires by Daughters' Year of Birth**

| Year dropped | Daughters of proved sires | | | | |
|---|---|---|---|---|---|
| | No. dropped | | Lb. milk | Percent fat | Lb. fat |
| 1922 | 9 | | 7587 | 3.97 | 301 |
| 1923 | 11 | | 8365 | 4.21 | 352 |
| 1924 | 14 | | 8017 | 4.30 | 345 |
| **Total** | **34** | **av.** | **8016** | **4.19** | **336** |
| 1925 | 16 | | 7462 | 4.33 | 323 |
| 1926 | 12 | | 7534 | 4.30 | 324 |
| 1927 | 23 | | 8303 | 4.00 | 332 |
| **Total** | **51** | **av.** | **7858** | **4.16** | **327** |
| 1928 | 8 | | 7845 | 4.23 | 332 |
| 1929 | 18 | | 7502 | 4.04 | 303 |
| 1930 | 17 | | 6408 | 4.18 | 268 |
| **Total** | **43** | **av.** | **7133** | **4.14** | **295** |
| 1931 | 22 | | 7548 | 4.19 | 316 |
| 1932 | 25 | | 6455 | 4.42 | 285 |
| 1933 | 24 | | 7013 | 4.42 | 310 |
| **Total** | **71** | **av.** | **6982** | **4.34** | **303** |
| 1934 | 18 | | 7770 | 4.12 | 320 |
| 1935 | 28 | | 8898 | 4.12 | 367 |
| 1936 | 20 | | 8735 | 4.17 | 364 |
| **Total** | **66** | **av.** | **8541** | **4.13** | **353** |
| 1937 | 24 | | 8179 | 4.23 | 346 |
| 1938 | 20 | | 8807 | 4.26 | 375 |
| 1939 | 10 | | 8940 | 4.34 | 388 |
| **Total** | **54** | **av.** | **8553** | **4.27** | **365** |
| 1940 | 2 | | 7819 | 4.58 | 358 |
| 1941 | 8 | | 9546 | 4.35 | 415 |
| 1942 | 1 | | 8300 | 4.48 | 372 |
| **Total** | **11** | **av.** | **9119** | **4.40** | **401** |
| 1943 | 3 | | 10166 | 4.61 | 469 |
| 1944 | 11 | | 10701 | 4.33 | 463 |
| 1945 | 11 | | 9366 | 4.34 | 407 |
| **Total** | **25** | **av.** | **10049** | **4.37** | **439** |

FIG. 1—Average production by 3-year intervals for daughters of proved and unproved sires.

of milk and 135 lb. of fat. The average fat test of the herd has been increased from 4.0 to 4.4 percent. Because no females have been brought into the herd since 1922 and because management conditions have been kept fairly constant, improvement in the herd can be attributed largely to the service of desirable proved sires. Before 1930 most of the sires used in the herd were proved on the basis of Advanced Registry records. Such proofs, being based on selected daughters, did not repeat when based on unselected records on all daughters. However, after 1930 the sires selected for use in the Reymann herd were proved on the basis of either D.H.I.A.* or H.I.R.† records. With very few exceptions, the daughters of these bulls were better than their dams.

As previously stated, young unproved sires have been used on part of the herd since 1938. The first calves by unproved sires were dropped in 1939. The averages of the first records of these daughters by 3-yr. intervals are given in Table 2 and pictured in Figure 1. Since 1939, 88

*Dairy herd improvement association.
†Herd improvement registry.

daughters of unproved bulls have averaged 9526 lb. of milk and 417 lb. of fat as compared with 9586 lb. of milk and 419 lb. of fat for the 46 daughters of the proved sires. This favorable comparison of the daughters indicates the wisdom demonstrated in the selection of the young unproved bulls. Such bulls selected for use were usually sons of good proved sires and out of consistently high-producing cows from good cow families.

One of the reasons for herd division in 1946, as explained previously, was the success encountered in selection of young bulls before that year, and it seemed that more study on this particular problem was needed.

## PROVED SIRES—WHAT TO LOOK FOR

Perhaps no subject in the field of dairy-cattle breeding has received more written and verbal comment than that of proved sires. Like any good subject, it has been treated correctly in some instances and at other times has been deviously twisted and abused to suit biased objectives. It is well, then, to consider the problems involved in selecting a proved bull from the facts available.

### Herd Sire Must Be Better Than Present Herd

First it must be appreciated that many factors are involved in attempting to determine whether a proved sire is good or not. A proved sire may be good in one dairy herd and entirely unsatisfactory in another. This frequently occurs because of the varying levels of production in our dairy herds. As a general rule, however, most dairymen are pointing toward a practical goal in production. A 360-lb. D.H.I.A. herd average is very creditable and one of which any dairy farmer can be truly proud. However, a 400-lb. average can be attained by every intelligent dairyman who works without major handicaps. This type of progress and achievement cannot be realized overnight. It is a long-time proposition; the final goal can be delayed by any one of a number of unfortunate occurrences.

**Table 2—Average Production (2 x 305-day M.E. basis) of Daughters of Unproved Sires by Daughters' Year of Birth**

| Year dropped | Daughters of unproved sires | | | |
|---|---|---|---|---|
| | No. dropped | Lb. milk | Percent fat | Lb. fat |
| 1939 | 16 | 8623 | 4.40 | 379 |
| Total | 16 av. | 8623 | 4.40 | 379 |
| 1940 | 16 | 9171 | 4.37 | 401 |
| 1941 | 10 | 9837 | 4.14 | 407 |
| 1942 | 19 | 9808 | 4.34 | 426 |
| Total | 45 av. | 9588 | 4.30 | 413 |
| 1943 | 9 | 9904 | 4.54 | 450 |
| 1944 | 13 | 9803 | 4.39 | 430 |
| 1945 | 5 | 10450 | 4.60 | 481 |
| Total | 27 av. | 9956 | 4.48 | 446 |

In most cases, however, dairymen should set their sights a little higher than their present herd average and work to reach that goal. This poses a very fundamental question that all must face in selecting future herd sires. Bulls must be selected that will transmit higher levels of production than the present herd average. This is essential for gradual improvement in a dairy herd.

## How Many Daughters to Prove a Bull?

At West Virginia University a study was made to determine how many dam daughter comparisons were needed to prove a sire. All the records possessed by the Ayrshire Breeders' Association were available. All proved sires in the breed that had 15 or more tested daughters in the same herd and out of tested dams were used for this investigation.

There were 154 such sires with 15 or more daughters, 141 with 16 or more, 132 with 17 or more, 124 with 18 or more, 114 with 19 or more, and 103 with 20 or more daughters. These daughters were divided into groups of the first 5 daughters and the next 10 daughters, first 6 and next 10, first 7 and next 10, first 8 and next 10, first 9 and next 10, and first 10 and next 10. The average of the production records for the daughters in each of the above groups was calculated. Then, comparisons were made between the averages of the first 5 and the next 10, between the average of the first 6 and the next 10, and so forth.

The results indicated that the first 5 unselected daughters are about as reliable as the first 6, 7, 8, 9, or 10 daughters in estimating what the next 10 will produce. The study showed that the small degree of increased accuracy gained by waiting for more daughters to complete records is unwarranted, since the full use of a particular sire may be delayed while waiting for more conclusive proof. Since the value of any proved sire depends upon his actual proof and his age, both of these factors should be considered. If too much accuracy in his proof is insisted upon, then some of the bull's usable months before he reaches an inactive status will be sacrificed.

## Insist on Unselected Records

It should be noted that emphasis in this research was on *unselected* daughters. As soon as the matter of *selected* records enters the picture, the value of production information and the possibility of measuring transmitting ability are severely curtailed, and the results biased.

Insofar as breeding programs are concerned, production testing is of value in indicating the ability that any particular animal has to transmit to his or her offspring the capacity to produce milk and butterfat. When analyzing the production records of any animal or the offspring of any animal, every single record of that particular individual should be studied. Selected information, such as the highest record for each animal, should not be accepted as evidence of transmitting ability. For example, an animal may be 7 or 8 years old and yet the owner may quote only one record on that animal. That should cause a prospective purchaser to suspect that this is selected information. These and other

TOP: HILL TOP MAJOR DOUGLAS, 14949. Photographed in 1923 at 11 years 10 months of age. One of the original proved bulls used in the proved-sire experiment.

BOTTOM: CACAPON LINDY 6th, 57230. Bred by the West Virginia Agricultural Experiment Station and now in heavy use in the herd. His proof—10 daughters average 8,960 M, 4.32%, 387 F. 10 dams average 8,293 M, 4.03%, 334 F. Equal Parent Index 9,627 M, 4.61%, 440 F. First seven classified daughters average 85.1.

records should be obtained before evaluating the breeding value of that animal.

### Total Daughters of Testing Age Compared with Number of Daughters Tested

When appraising the proof of a sire, one should know the *total* number of daughters dropped and of producing age; this number should be compared with the number of *tested* daughters. If there is a large discrepancy in these figures, one should make sure that there is a logical explanation why some of these animals were not tested. Otherwise the conclusion can be drawn that there *was* a good reason for not testing some animals. This is one flaw that is flagrantly evident among professional pedigrees. This sort of information is necessary but will not be provided until farmer buyers insist on having it. The sooner farmers demand all the records, the sooner the number of untested daughters will appear on all creditable pedigrees.

### Is Uniform Production of Daughters Necessary?

For many years cattle breeders have written and spoken of a sire's ability or lack of ability to produce uniform offspring. Compare, for example, two bulls. One bull's first 10 daughters range in production from 375 to 425 lb. fat. Another bull has 10 daughters ranging in production from 200 to 650 lb. fat. The first bull is referred to as being relatively homozygous (his daughters are uniform) for production and the second bull as being heterozygous (daughters are not uniform) for production. Dairymen have believed that the so-called "homozygous" bull is more desirable because his ability to transmit production can be counted on to be within certain narrow limits, and there would be little chance of his siring a really low-producing daughter.

Studies at the West Virginia Agricultural Experiment Station show these assumptions are not necessarily true. A study was made of all proved sires in the Ayrshire breed (totalling 103) with 20 or more daughters recorded in one herd. The daughters were then divided into the first 10 daughters dropped and the second 10 daughters dropped, all sired by one bull. It was found that there was no close association between the variability in the first 10 and the variability in the second 10. In other words, the first 10 daughters might all be between 375 and 425 lb. fat, but analysis of the second 10 daughters would show a very considerable range. Similarly, the situation was often reversed. (See Figure 2 for examples of each kind of bull.)

These results are quite similar to work done on Holstein-Friesian H.I.R. proved sires at the Iowa Experiment Station*. The Iowa workers found that uniformity of a sire's get was not highly repeatable from one group of 10 daughters to a successive group of 10 daughters. It would appear, therefore, that on the average one is apt to be disappointed in

*Johnson, Leslie E. 1945. The Importance of Uniformity of Get in Evaluating a Sire. J. Dairy Sci. 28: 109-120.

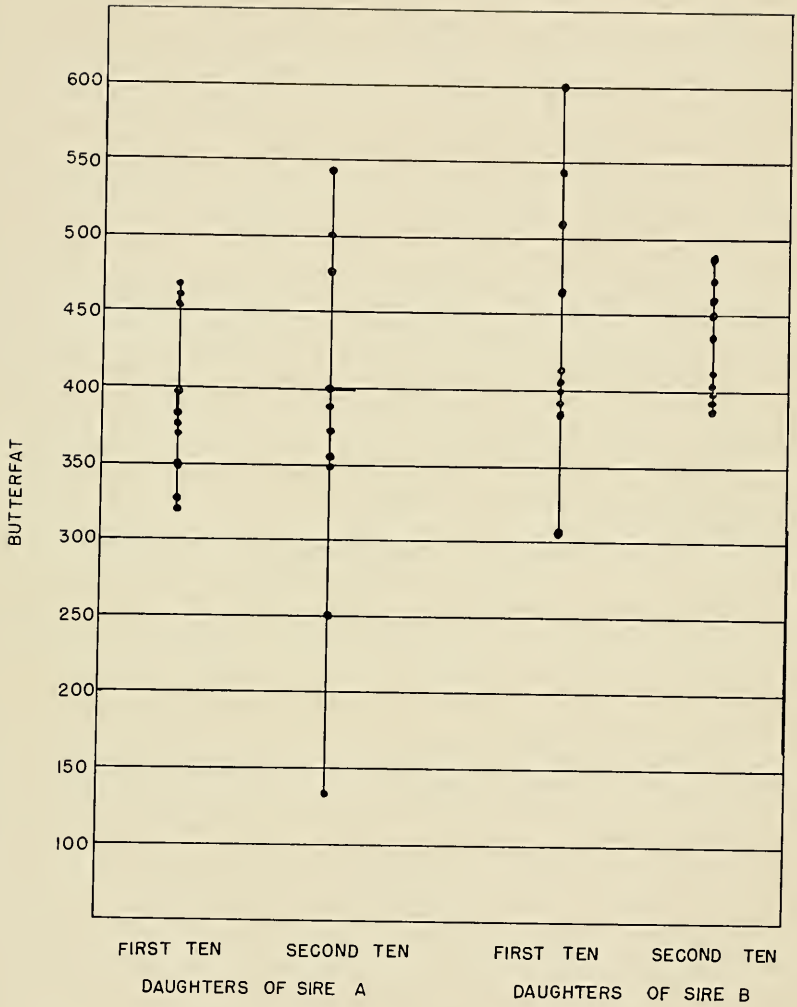



FIG. 2—Butterfat production records showing change in variability in production records of 2 consecutive sets of 10 daughters for 2 Ayrshire sires.

searching out and counting on a bull that is supposed to sire daughters with rather uniform production. Under the present methods of breeding dairy cattle, it seems unlikely that there are very many bulls "homozygous" for high butterfat production. Only where extreme inbreeding has occurred, would such animals be expected to appear. *The apparent homozygosity of some bulls today is mainly caused by chance and is not a permanent characteristic of the sire.*

### Significance of the Plus or Minus Sign on a Bull's Proof

Frequently too much emphasis has been placed on the plus or minus value of the herd sire; i.e., whether he raised or lowered the average production of the daughters in comparison with the dams to which he was bred in the herd in which he was used. Whether he was plus or minus is not the important point to consider, but rather the production level of the dams to which he was bred. For example, a bull in one herd might show a plus 25-lb. butterfat performance when bred to 300-lb. dams, while in another herd a bull might show a minus 5-lb. performance when bred to 430-lb. dams. In this particular instance the minus bull, on the surface at least, is a superior sire when compared to the plus bull. The value of proved bulls is often determined on a plus-and-minus basis which can be extremely misleading in determining the true transmitting value of the bull. The level of production of the dams must be known. In comparing bulls it is quite a common procedure to calculate equal-parent indexes on the sires. This calculation is easy to make and is done by multiplying the daughters' average by 2 and then subtracting the average of the dams.

### Feeding and Management Can Affect a Bull's Proof

Every student of dairy-cattle breeding has seen examples of proved bulls that apparently did an excellent job in one herd and then proved out very poor in another. Dairymen frequently have ascribed this variance to the theory of "nicking."

A study of the data from the Reymann Memorial herd shows, however, that the majority of bulls do perform equally well in separate herds, if feeding and management conditions are relatively similar and also if all daughters are tested and if no selection for testing is practiced. For example, the proved Ayrshire sire, Penshurst Romeo, was used in at least four herds. He had four different equal-parent indexes as a result of his proof in these herds. They were as follows: 321, 362, 373, and 481 lb. of butterfat.

On the surface, these results would appear to support the nicking theory. Careful analysis, however, shows that in only two herds were all daughters tested and were management conditions quite similar. In the other two herds the management conditions were poor in one, while in the other only those daughters were kept and tested that showed promise of producing more than their dams.

In the Reymann Memorial herd 24 daughters of Penshurst Romeo averaged 351 lb. of butterfat. The dams of these daughters averaged 340 lb. Thus the sire has an equal-parent index of 362 lb. In the other herd in which all his daughters were tested, with management conditions roughly similar, 12 daughters produced on the average 386 lb. of butterfat. Their dams averaged 399 lb. Here the sire has an equal-parent index of 373 lb. When the daughters were selected for their promise of showing considerable increase over their dams, which averaged 407 lb., the daughters averaged 444 lb. In this herd, Penshurst Romeo had an

equal-parent index of 481 lb. On the fourth farm, where management conditions had recently become very poor, the daughters averaged 385 lb. as compared to 449 lb. for the dams. In this case, the equal-parent index for Penshurst Romeo was 321 lb. of butterfat.

Another proved sire, Cacapon Leto 18th, is an excellent example of the uniformity of results that most generally occur when management is similar and when no selection of daughters is practiced in those herds in which a proved sire is used. This sire dropped a total of five females in one herd where management conditions were comparable to those in the Reymann Memorial herd. These five daughters averaged 398 lb. of butterfat. Their dams averaged 365 lb. and the sire has an equal-parent index of 431 lb. In the Reymann herd 16 females were dropped. Again every one was tested. The 16 daughters averaged 397 lb. of butterfat and their dams 337 lb. Here the sire has an equal-parent index of 457 lb.

It should be appreciated, of course, that it is very difficult to assemble any mass of data to prove this in a large number of herds. These figures do indicate, however, that the theory of nicking certainly is not alone responsible for the varying results obtained from the use of any particular proved sire in more than one herd.

## Select for Type Correction

Results in the Reymann Memorial herd have proved that the type of a proved bull's daughters should be considered when selecting a herd sire. Udders that may be seriously pendulous and legs that may be badly sickled or cow-hocked can become real problems in a breeding herd of cattle if these characteristics are concentrated through use of several sires carrying the inheritance of these undesirable traits. Nearly every dairy herd has some fault that should be corrected as soon as possible. If a group of daughters of one bull, for example, should be shallow in the heart and sloping in the rump, the bull chosen to breed to those animals should be strong in these physical characteristics.

The lives of many dairy cattle are greatly shortened because of poorly shaped udders that break away from the body at an early age and are easily injured and susceptible to mastitis. In the Reymann herd some of the families were so badly sickled in their legs that they had to be removed from the herd by the time they were 6 or 7 years of age. These characteristics have been corrected by using proved bulls that had previously sired daughters with straight, sound legs.

## Regular Calving

Results in the Reymann herd indicate that regularity of calving may be an inherited characteristic and may be passed from a sire to his sons and daughters and from dams to their sons and daughters. While these results are not conclusive, there is strong evidence that dairymen, when studying the records of proved bulls, should check the breeding records of the daughters to determine if they come into heat regularly and drop

a calf every 12 or 13 months. This is an important consideration and should not be overlooked.

### Health of Bull Important

Before any proved sire is purchased for use by a dairyman or an artificial breeding establishment, it is important that the health of the bull be thoroughly checked. This examination should be made by a competent veterinarian, and the bull should be declared sound and free from diseases such as Bang's, tuberculosis and trichomoniasis. In addition, his breeding record should be a good one. Experience has demonstrated that failure to check on the health of a new herd sire may lead to infection and ruination of a herd of cattle.

### Integrity and Ability of Breeder

Any discussion of the important factors to consider in selection of a proved sire would be incomplete without considering the integrity of the breeder from whom he is to be purchased. The honesty and integrity of the man from whom he is purchased must be above question and is of paramount importance when making a selection. Ira Inman, loved and respected former secretary of the Brown Swiss Association, used to give this advice to new breeders of Brown Swiss cattle: "First go to several herds where there are animals for sale. On your first trip, don't pay too much attention to the cattle on hand. Attempt to evaluate the man who is in charge or who owns the herd. After you have made your first trip, sit down and decide which man or men you desire to deal with. From that point on, it is not particularly important which herd you select from because you have a reliable man, an honest man, who will make good for you and who will give you assistance in your breeding work."

## WHAT TO LOOK FOR IN SELECTING A YOUNG BULL

Although it is advantageous for every dairyman to use a good proved bull, only a very few have an opportunity to own one. This is due to the fact that good proved bulls are scarce and high-priced. There are not nearly enough proved sires for every breeder and, unless the dairyman has access to service from an artificial breeding association, he will probably have to rely on use of a young bull. Some of the research done in the past eight years at the West Virginia Agricultural Experiment Station has been along the lines of studying various ways and means of properly selecting young bulls.

### His Sire Should Be Well Proved

Results of much research work have shown that the first and most important point that dairymen should look for in the pedigree of a young bull calf is the proof of his sire. One should not settle for anything less than a son of a good proved sire. This sire should have as many producing daughters as possible, with five as a minimum. They should

VISTA GRANDE GUS, 79757. Young bull now being proved in the Reymann Memorial Herd. None of his daughters has completed records as yet. His sire is Vista Grande King, Excellent and Approved, who has 36 daughters that average 437 lb. of butterfat as compared with 419 lb. for their dams. His dam is Vista Grande Douglas Bloom, Excellent and Approved, who has eight records that average 494 lb. of butterfat. She also has two daughters that average 445 lb. of fat.

have produced considerably better than their dams if the bull was bred to low-producing or mediocre cows. If, instead, he was bred to high-producing animals, then the daughters should show production well above the present herd average of the dairyman making the selection.

The dairyman should always insist on records that are quoted in farmer terms; *i.e.,* two-times-a-day milking and 305-day lactations. If it is at all possible, the dairyman should learn whether the records were made under conditions of feeding and management that are similar to those on his own farm. If conditions were considerably better, then it is wise to reduce the records of the daughters of the sire to what they might have been if made in his own herd.

It is well to repeat again the importance of making sure that the sire of his calf is proved on the basis of *unselected* records. It is true that a sharp operator can be a real master in selecting certain daughters for high records and rejecting others that might not look as good when compared with their dams. If an old proved bull has been used in a community where much production testing has been done and only a few daughters are listed in his proof, the dairyman has reason to be suspicious of the indicated breeding value of the sire.

MAGICIAN OF WINDROW, 90579. A carefully selected young bull now being used in the unproved half of the herd. His daughters' records and type conformation will be compared with their dams to determine if the methods used in his selection were correct.

## Dam's Unselected Records Important

Many dairymen who are interested in purchasing a young bull pay a great deal of attention to the dam's records. Chances are that most attention is given to one high record that the dam may have made. If such is the case, they are usually disappointed in the sire they select.

One should insist that all the records be given on the dam of the bull calf under consideration. Recently, the authors completed a study of 6,000 records of production provided by the Ayrshire Breeders' Association. They found that, on the average, a selected record on the dam results in the animal transmitting only about 10 percent of her superiority over the herd average. For example, suppose a cow has a high selected record of 550 lb. of butterfat and the herd average is 350 lb. Although her record is 200 lb. above the herd average, she will transmit only 10 percent of 200 lb., or 20 lb. above the herd average. Hence, her offspring will receive her inheritance at the 370 lb. butterfat level.

On the other hand, suppose the cow has one unselected record of 550 lb. of butterfat. Studies show that on the average she will transmit

about 25 percent of her superiority. In that case, she would pass about a 400 lb. level to her offspring. If the cow has five unselected records that average 550 lb., she will be transmitting to her offspring about 50 percent of her superiority above the herd average, or 450 lb. of butterfat.

The above figures are based solely on averages. Of course, there will be considerable variation in individual cases. Some will be lower and some will be higher. This research illustrates, however, that little reliance can be placed on use of a single *selected* record as a measure of breeding worth.

### Records of Dam's Daughters Important

For many years dairymen and teachers have advised that the records of daughters of a cow are more important than the cow's own records in estimating her breeding worth. Studies at the West Virginia Agricultural Experiment Station, based on thousands of records, show that it takes about three daughters with unselected records to give information as reliable as any one unselected record of a cow in predicting her breeding value. The work emphasizes the importance of having unselected records on the dam and on as many daughters with unselected records as are available. With this information, along with the right information on the upper part of the pedigree, the breeding worth of a future bull can be forecast fairly accurately.

One error usually made when considering the value of a cow on the basis of the production of her daughters is that the sire's influence on the offspring is quite often not known or, if known, is not taken into consideration. When a bull is proved, the daughters are compared with their dams and the assumption is that the sire is responsible for the difference, provided feeding and management conditions are similar. The same comparisons should be made when studying the daughters of a cow in an effort to forecast the dam's breeding value.

### Know the Type of His Nearest Relatives

When a young bull is selected for use in the herd, it is important to know the type of his sire and of his sire's daughters, as well as the type of the calf's dam and of her daughters. Type conformation should not be based on show ring winnings of these animals, but rather on their type classification as judged by an official inspector. The prospective herd sire should have a sire and dam that do not, themselves, show any major physical weaknesses, and they should also indicate through their sons and daughters that they do not transmit any physical deficiencies. The future herd sire should have every possibility of developing into a true-to-type, strong-legged, strong-bodied animal with good prospects of being able to "take it" over a period of years.

### Beware of "Pedigree Poppycock"

It is true that many dairymen, when selecting a young bull, make the selection not on the basis of the production and type of his sire, his dam, or her daughters, but rather on a great deal of superfluous informa-

tion that is of little real value in determining the breeding worth of the bull calf in question. For example, pedigrees often contain information pertaining to sale prices, famous remote ancestors, certain show ring winnings, and so on. At auction sales and in high-pressure advertising it is not uncommon to hear or see statements referring to the calf's fifth and sixth generations of ancestors. It is well to remember that the percentage of blood that one great-grandparent contributes is only 12½ percent or one-eighth of all the blood of the animal in question. This pedigree poppycock is the very poorest basis upon which to select an animal for any breeding program.

For most purposes, if the information on the sire and dam is complete and fulfills requirements, there is little reason to go back to grandparents, great grandparents, and "Mayflower ancestors." Certainly information of the kind that research has shown to be important in the *first generation*, would materially strengthen the pedigree if such information were to be found in the second and third generations. However, the first generation is of greatest importance, and only when information on the sire and dam is incomplete is it essential to pay much attention to the grandparents. Figure 3 shows the right kind of information for a good pedigree.

## COW FAMILIES—WHAT MAKES A GOOD ONE?

For many years teachers, breeders of dairy cattle, and research workers have stressed the importance of selecting the proper bull for use in a herd to the extent that selection of good cows and cow families was often neglected. It has been only recently that the importance of good cow families has been recognized and brought to the attention of dairy-cattle breeders. There is a real lack of research in this field.

Some of the work accomplished in the Reymann Memorial herd points out the importance of good cow families and what to look for in appraising the worth of a family. As explained earlier, no female dropped in the herd can be removed until she completes at least one record. It has been practically impossible, therefore, to cull an undesirable family from the herd. As a result, some excellent contrasts in cow families are available.

### High Yearly Production Essential

Obviously, high production is one of the essentials of a good cow family. The production of members of such a family should average considerably higher than the average of other cows in the herd in which they are kept. In addition, they should be capable of continuing this, year in and year out. As a group, members of outstanding cow families will reproduce higher-producing offspring than will other members of the herd.

### A Calf Every Year

Most dairymen will agree that any cow that makes 400 lb. of butterfat in 305 days is an asset to the herd, particularly so if the cow drops a

# A GOOD PEDIGREE

**BULL CALF**

All Records 305 Days 2x M.E.

**Cacapon Lindy 6th, App., Very Good**

10 daus. ave. 8,960 M., 4.32%, 387 F.
10 dams ave. 8,293 M., 4.03%, 334 F.
Equal Parent Index 9,627 M., 4.61%, 440 F.
First 7 classified daus. ave. 85.1.

**Cacapon Lily by Leto 18th, Very Good**

4 recs. ave. 12,569 M., 584 F.
1 dau. with 4 recs. ave. 9,506 M., 433 F. Daughter classified Very Good.
1 son with 11 daus. that ave. 9,849 M., 4.17%, 411 F. Son classified Very Good.

**Penshurst Lindy, Approved**

80 daus. ave. 8,784 M., 4.42%, 388 F.
80 dams ave. 9,007 M., 4.13%, 372 F.
Equal Parent Index 8,561 M., 4.71%, 404 F.
Ave. classification score of 17 classified daughters 83.1.

**Cacapon Jewel by Leto 15th, Excellent**

9 recs. ave. 10,558 M., 3.79%, 400 F.
Lifetime production thus far: 100,103 M., 3.81%, 3810 F.
1 dau. with 2 recs. ave. 10,522 M., 448 F. Daughter classified Very Good.

**Cacapon Leto 18th**

23 daus. ave. 8,360 M., 4.21%, 352 F.
23 dams ave. 7,281 M., 4.24%, 309 F.
Equal Parent Index 9,439 M., 4.18%, 395 F.

**Cacapon Nita by Caesar, Excellent**

7 recs. ave. 12,633 M., 562 F. Actual lifetime production 125,326 M., 4.52%, 5661 F. 5 daus. have 11 recs. ave. 11,178 M., 500 lbs. F. Ave. classification score of daus. 85.0.

FIG. 3.

calf each year. On the other hand, even though she may be a 400-lb. producer, if she takes a long vacation between each calving, she is cheating the dairyman, and a careful eye should be kept on her and her entire family, because it is fairly well proved that regular calving may be affected to a certain extent by inheritance.

A study of two families in the Reymann herd shows quite a contrast in breeding efficiency. If a cow carries a calf for 9 months of the year she is considered to have a breeding efficiency of 100 percent. The Nita family possesses a breeding efficiency of 93 percent, while the Betty family has only 84 percent breeding efficiency as a family. The following are breeding efficiency records in percentages for 12 members of the Nita family: 105, 77, 88, 60, 92, 91, 100, 100, 100, 100, 100, 100. Percentages for eight members of the Betty family are as follows: 88, 100, 91, 88, 61, 95, 77, 72.

Other families in the Reymann herd show appreciable differences in breeding efficiency. This means that this factor should be observed rather carefully when selecting foundation cows over a period of years.

## Resistance to Diseases

Work at the West Virginia Agricultural Experiment Station, as at other institutions, has indicated that some cow families are apparently more resistant to diseases than are others. Two families in the Reymann herd offer notable comparison. No members of the Nita family, even though they have been consistently high producers, have ever been removed from the herd because of mastitis. On the other hand, in the Anna family five out of ten members have been removed from the herd because of mastitis or now have the disease in one or more quarters. It is thought that the type of udder is closely related to the susceptibility of cows to mastitis; especially pendulous udders are easily injured. In selecting breeding stock it is very important that a dairyman does not overlook the matter of resistance to disease or tolerance to certain kinds of diseases.

## Long Life

Longevity is another very desirable characteristic of good cows and good cow families. The Nita family offers a good example of this characteristic, for members of this family have produced extremely well over many years, have been resistant to diseases and, in most instances, were not culled out of the herd because of any breeding difficulties.

From a profit point of view, it pays to have cows that produce over a long period of time. It is generally estimated that a cow in her first two lactations merely pays for the cost of raising her to a producing two-year-old. Only in her third lactation and thereafter does she begin to render a clear profit.

It would appear that the presence in a dairyman's herd of several old cows from one family is a good over-all indication of the desirability of that family. It is, in reality, a final measuring stick for several desirable characteristics.

### Persistency

Although no definite study has been made in the Reymann Memorial herd concerning persistency, the workers believe it well worth considering. By persistency is meant the ability of cows to produce a moderately good flow of milk right up to time of drying off. In the opposite characteristic, or the well-known "flash in the pan," the cow freshens and is an extremely heavy milker for the first few months, then begins to fall off rapidly and dries up long before she is scheduled for a rest. There is strong indication that persistency is an inherited characteristic. The Nita family apparently has this characteristic, while certain other families in the Reymann Memorial herd dry off early in their lactations.

## SOME CONSIDERATIONS OF TYPE

The importance of proper type when selecting a proved or a young bull for use in a herd has already been discussed. However, there are some further type considerations, based on studies conducted at the West Virginia Station, that cast new light on this phase of dairy-cattle breeding.

The question might be asked, "Why is it that, when a grand champion sire is mated to a grand champion cow, the resulting offspring is not always a grand champion?" Perhaps the offspring is not even of acceptable type. It is possible that the answer is found in the results of a study of thousands of records, which reveal that the heritability of classification ratings for type is only about 0.3. This means that offspring inherit about one-third of the observed superiority of the parents' type. This proves that type is transmissible and the type of a herd can be improved by selection of animals that are above the herd average in type. On the other hand, improvement is not nearly as rapid as one might expect if the 0.3 heritability figure were not known. Another way of saying it is that, on the average, it would be expected that the daughters of outstanding parents will be better than the herd average by one-third of the difference between the herd average for type and the average of the type ratings of the parents. For example, if the herd average is 82.5 points and the average of the type ratings of the parents is 87.5 points, then the offspring of these parents can be expected to average 82.5 + 0.3 times 87.5 − 82.5, or 84.

### Type and Production

Further work based on study of the records of 5,177 Ayrshire cows shows that there is a small positive relationship between classification ratings and production of butterfat. Within herds there was an average increase of 13 lb. of butterfat for each increase of one grade on the type scale. For example, if the average of the animals classified Good Plus in a herd had production records averaging 380 lb. of butterfat, it would be expected that, on the average, the animals classified Very Good in the same herd would have records averaging about 393 lb. of butterfat. It

must be remembered that these are average figures and that there are a great many variations within and between groups.

It was found that the relationship between the type rating of a cow and her first butterfat record is low. Likewise the relationship between her type rating and her butterfat record, begun nearest the date of classification, was not large. Furthermore, the relationship between her type rating and the average of all her butterfat records was low. While these relationships are statistically significant, they are so small as to have little practical importance. It should also be pointed out that the relationship between type and production improves as more records and more classifications are averaged.

Dairymen would be foolish to try to make any satisfactory increase in production in their herds by selecting on the basis of type only. On the other hand, when selecting for production alone, not a great deal of progress will be made in improving the type of the herd. Consideration of both type and production is necessary, if the herd is to be improved in these characteristics.

## Variations in Type Ratings

The reasons why the type-classification rating of a cow varies from time to time over a period of years have been studied extensively in the Reymann Memorial herd. From May 1942 through December 1946, 139 producing females were classified, approximately three times per year, by inspectors of the Ayrshire Breeders' Association. Considerable variation in type rating of individual cows was shown over a period of years. (See pictures on pages 24, 26.)

These variations were due to several causes including age, stage of lactation, degree of fleshing of the animal, and the differences in opinions of the judges. Analysis of the data, however, shows that the majority of the wide variations were due to failure of inspectors to appraise equally certain faults of a cow. Defects in udder, feet, and legs seemed to cause the most trouble. It would appear, therefore, that much more work must be done by the breed associations and the inspectors to set uniform deductions for these more important defects. Breeders who have been having their herds classified by official inspectors of their respective breed associations are finding that there is considerable variation among inspectors and also between classifications of any individual animal.

On the basis of present experience, it would appear that an average of several type ratings of an individual cow is a far more accurate guide to her true type than is one official rating which can never be lowered regardless of future type changes of the cow.

## Classification of Heifers May Be Valuable

The question was raised several years ago as to whether the type-classification program, as applied to cows, can also be used for establishing the type of young heifers. A project was inaugurated in the Reymann Memorial herd to determine the repeatability of heifer classifica-

tions at 6-month intervals as well as the correlation between the several classifications of a heifer and her classification after freshening.

So far 102 Ayrshire heifers have been classified every 6 months, starting at about 6 or 12 months of age and continuing in some instances to 5 years. The type ratings were made in each instance by an official inspector designated by the Ayrshire Breeders' Association.

Table 3 shows that the majority of heifers in a low-type group at 6 to 12 months of age remained in a similar group after being rated as milking cows. Those in the middle group seemed to remain there, and those in the upper group were still above average when they were classified as 3-, 4-, and 5-year-old cows.

The results indicate that a reasonably accurate prediction of a cow's future conformation can be made on the basis of one or several classifications as a young heifer. With improvement in classification techniques, it may be possible to improve this program materially in the next few years.

## MAXIMUM SIZE IMPORTANT

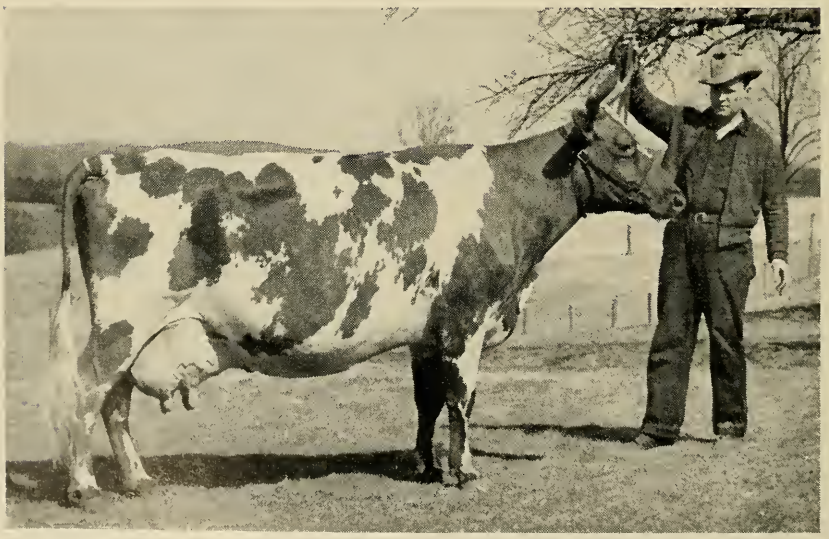
It has been proved that dairymen should strive for at least average size in their cattle. In fact, the common assumption is that, everything else being equal, the large cow usually is a higher producer than the small one. The old adage, "A good big man is better than a good little man," can be applied in speaking of size of dairy cattle.

Certain observations on the way dairy cattle grow have been made in the Reymann Memorial herd. Studies have shown that it is not enough to say that dairy cattle grow up; they grow up and then down. Heifers practically reach their mature heights by the time they are three years of age. They continue to increase in body weight, however, until they are seven or eight years old. This increased weight is largely through a deepening of the body, although at the same time there is some increase in the width of the animal. With these facts in mind, we should not expect the little two-year-old to grow to be a big cow: She will not if she has been growing normally. Since she has made practically all of her skeletal growth, she can, at best, develop only into a good little cow.

**Table 3—Average Classification Ratings by Groups Before and After Calving**

| Average rating of each animal before calving by groups | Number of animals | Average of each group before calving | Average of each group after calving |
|---|---|---|---|
| Below 80.5 | 14 | 78.6 | 80.1 |
| 80.5 — 82.5 | 34 | 82.0 | 81.5 |
| 82.6 — 85.0 | 31 | 84.4 | 83.0 |
| Above 85.1 | 23 | 87.1 | 84.5 |

CACAPON NITA BY CAESAR. This is an example of the variation in appearance of an animal depending on her stage of lactation and her age. In the top picture, this cow at 10 years of age was classified excellent. She had been fresh 1 month. In the bottom picture, this same animal at 8 years was classified very good in the ninth month of her lactation.



## SUMMARY

A 30 year-summary has been presented of the experimental research in breeding dairy cattle accomplished with the Reymann Memorial Ayrshire herd. This has been supplemented with research on thousands of records furnished by the Ayrshire Breeders' Association through a cooperative project with the West Virginia Agricultural Experiment Station.

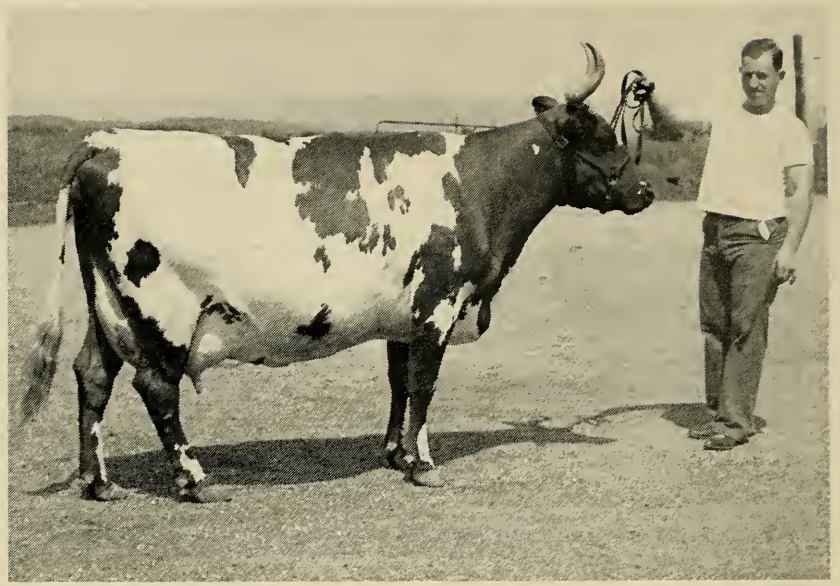
Throughout the years of this experiment all milking cows have been fed and managed according to strict rules and regulations adopted when the project was begun. All normal females born in the herd have completed at least one lactation before being sold. No females have been purchased.

The original plan of the experiment was to compare outcrossing with linebreeding, through use of proved sires, as a means of improving both type and production of dairy cattle. Because of the difficulty of locating linebred proved sires, the project developed into a study of the continued use of good, usually unrelated, proved sires. The project has been revised several times to include studies on other phases of dairy-cattle breeding, including type conformation, and recently to study the effect on type and production when carefully selected young unproved bulls were used on part of the herd.

Through use of proved bulls the herd has increased in production since 1933 by about 3,000 pounds of milk and 135 pounds of butterfat. The average test of the herd has been increased from 4.0 percent to 4.4 percent, and some improvement in type has been made.

Results of the experiment have shown that there are several important points that should be considered in selecting a proved sire:

1. The sire must be better than the present herd or at least as good if the production level is already high.
2. The first five *unselected* daughters of a bull are about as reliable as the first 6, 7, 8, 9, or 10 daughters in estimating what the next 10 will produce.
3. The records of the daughters of a proved sire should be unselected.
4. The total daughters of testing age should be compared with the number of daughters tested. If there is great discrepancy, the proof should be studied closely for any logical explanation or reason why some of the animals were not tested.
5. Uniformity of production of sires' daughters is not important when selecting a proved sire.
6. The significance of the plus or minus sign on a bull's proof depends upon the level of production of the dams to which he was bred and upon the feeding and management conditions to which all the animals were subjected.
7. Feeding and management can affect a bull's proof very materially.



CACAPON IRENE BY CAPT. CLIP. This comparison provides an excellent example of how cows change in appearance with age. In the top picture as a 7-year-old, this cow was classified excellent. Below, as a producing 4-year-old, she classified good plus.

8. Selections should be made to correct type defects of herd.
9. Daughters of the bull should calve every 12-14 months.
10. The bull should be free from disease.
11. Integrity and ability of breeder from whom bull is purchased should be known.

Important points to consider in the pedigree of a young unproved bull are:

1. The sire should be well proved.
2. His dam's unselected records are important. All the records of the dam under consideration should be known.
3. The records of his dam's daughters are important. Again, all the records of all the daughters of his dam should be studied.
4. The type of his nearest relatives should be studied thoroughly.
5. "Pedigree poppycock," such as high selected records and show ring winnings, should be overlooked.

Results have shown that good cow families can be developed by paying attention to the following attributes:

1. High yearly production.
2. The ability to have a calf every year.
3. Resistance to disease.
4. Long life.
5. Persistency or the ability to milk through an entire lactation.

Other studies in the herd, in cooperation with the Ayrshire Breeders' Association, have thrown light on problems relating to type conformation:

1. There is a positive relationship between type and production in Ayrshire cattle, but this relationship is small and dairymen would be foolish to try to make any satisfactory increase in production in their herd by selecting on the basis of type only. On the other hand, when selecting for production alone, not a great deal of progress will be made in improving the type of the herd. Subsequently, consideration of both type and production is necessary if the herd is to be improved in these characteristics.
2. From a study of the variations in type ratings of mature cows over a period of time, it was found that variations were due to several causes, including age, stage of lactation, degree of fleshing, and the differences in opinion of the judges. It was concluded that an average of several type ratings of an individual cow is a far more accurate guide to her true type than one official rating which can never be lowered regardless of future type changes in the cow.
3. Classification of young heifers has been studied. Results indicate that a reasonably accurate prediction of a cow's future conformation can be made on the basis of one or several classifications as a young heifer.

*"The lowing herd wind slowly o'er the lea"*